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ABSTRACT

The National Science Foundation's Divison of Science Resources Studies (SRS) has a legislatively mandated responsibility to collect, compile, and analyze information related to science and technology resources and impacts of those resources. The mandate consistitutes a broad charter requiring diverse activities. The products of these activities are of utility to a heterogeneous clientele, varying from governmental science and technology policymakers to institutional managers and research analysts. This compilation of project summaries has been prepared to provide various SRS users with a rapid overview of all current and recently completed SRS projects. All projects were either ongoing or completed during fiscal year 1984. The summaries include information on objectives, findings, methodology, authorship, and resulting publications/availability. Projects are organized in the following groups: (1) overview projects; (2) human resources (scientists, engineers, technicians), subdivided according to characteristics, education, employment, and projections; (3) funding of science and technology, subdivided according to government, industry, universities and colleges, and others; (4) outputs and impacts, subdivided according to innovations and inventions, bibliometrics, economic implications, and other areas; and (5) international science and technology. Lists of principal investigators and SRS intramural and extramural publications for 1974-1984 are provided in appendices. (JN)

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foreword

The Division of Science Resources Studies (SRS) engages in numerous activities to produce information and analyses pertinent to a fuller understanding of the magnitude, characteristics, and dynamics of the technical resources of the United States and of the other large, research and development (R&D) performing industrialized nations. Projects that produce this information either are staffed intramurally or consist of extramural activities supported through grants and contracts. The information generated is intended to be of interest to policymakers in all sectors of the national science and technology enterprise as well as to those who analyze the operation of this technical system. A need has been expressed for a compact reference volume that permits a rapid overview of all of the projects carried out by the Division and that provides a summary of each endeavor. This publication responds to such a need and is the fourth volume of an annual series. It presents an overview of the many facets that are being illuminated by SRS efforts. It also furnishes sufficient information on project objectives, methods, results, and references to facilitate user selection of projects for further investigation. Any constructive criticism or comments from the user community by which the format of this publication might be improved would be greatly appreciated.

Charles E. Falk, Director
Division of Science Resources Studies
Directorate for Scientific, Technological, and International Affairs

September 1984

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notes

The Division of Science Resources Studies (SRS) of the National Science Foundation (NSF) has a legislatively mandated responsibility to collect, compile, and analyze information related to science and technology resources and the outputs and impacts of those resources. Such a broad charter requires numerous activities, the products of which are used by a diverse clientele, varying from governmental science and technology policymakers to institutional managers and research analysts. The clientele are interested not only in the actual results of the various surveys and studies, but also in the nature of projects that are still ongoing. This compilation of summaries provides these various users with a rapid overview of all currently ongoing and recently completed SRS projects. Summary publications are issued on an annual basis.

All projects summarized in this publication were either ongoing or completed during FY 1984 (October 1, 1983, through September 30, 1984). The summaries include information on objectives, findings, methodology, authorship, and resulting publications. Projects for which "NA" is given under "Major Findings" and "Availability" are those that are ongoing and for which findings and resulting publications are not yet available. The summaries are organized in major substantive groups. Projects noted as being intramural are those carried out directly by the staff of the Division and may include information developed under SRS sponsorship by other Government agencies and by contractors. Extramural projects are those for which institutions and/or principal investigators are identified, and are supported through NSF grants and contracts. Appendix A is an alphabetical listing of all principal investigators so identified in the project summaries.

Publications are identified in the three formats used by SRS: *Highlights*, Detailed Statistical Tables, and Reports. A *Science Resources Studies Highlights* is normally restricted to four pages and presents the essence of the analyzed data in brief statements and in graphic and tabular form. As soon as feasible after the *Highlights* has been issued, survey data are released as Detailed Statistical Tables for the reference and convenience of other analysts and researchers. A more complete analysis is then developed and published in a Final Report. When the subject is one of an ad hoc nature, the publication is identified as a Special Report. The SRS Editorial and Inquiries Unit (EIU) maintains a mailing list by which users of SRS publications automatically receive copies of *Highlights*, Detailed Statistical Tables, and Reports. A listing of all SRS publications issued since January 1, 1974, is included as appendixes B and C of this publication.

Written or telephone inquiries concerning the nature and availability of data may be made to any of the following appropriate offices of the Division of Science Resources Studies, 1800 G Street, N.W., Washington, D.C. 20550:

R&D Economic Studies Section, Rm. L602	202-634-4625
Government Studies Group, Rm. L602	202-634-4636
Industry Studies Group, Rm. L602	202-634-4648
Universities, Colleges, and Nonprofit Institutions Studies Group, Rm. L602	202-634-4629
Scientific and Technical Personnel Studies Section, Rm. L611	202-634-4691
Demographic Studies Group, Rm. L611	202-634-4664
Supply and Education Analysis Group, Rm. L611	202-634-4787
Utilization Studies Group, Rm. L611	202-634-4655
Science Indicators Unit, Rm. L611	202-634-4682
International Scientific and Technological Studies, Rm. L611	202-634-4640

Written or telephone inquiries concerning the availability of SRS publications may be directed to EIU, Room L611, 202-634-4622 or 202-634-4623.

section I. overviews

PROJECT:
Academic Science/Engineering, 1972-83

Objective:

To provide consolidated biennial analyses of academic research and development (R&D) expenditures, the utilization of academic scientists and engineers, and the characteristics of the graduate science/engineering (S/E) student population.

Method:

Analyses are based on data selected primarily from three academic surveys: (1) Scientific and Engineering Expenditures at Universities and Colleges, FY 1972 through FY 1982; (2) Scientific and Engineering Personnel Employed at Universities and Colleges, January 1973 through 1983; and (3) Graduate Science Students and Postdoctorates, Fall 1975 through 1982.

Major Findings:

One out of every 10 R&D dollars was spent by universities and colleges in 1982 and one-half of the $10 billion devoted to basic research was performed in the academic sector. Between 1972 and 1982 R&D expenditures by universities grew at an average rate of 3% per year in real-dollar terms, and academic employment of scientists and engineers rose at about the same rate. The number of full-time S/E professionals rose 26% in 10 years, but part-timers increased by 77%. R&D involvement of S/E employees rose 29% between 1973 and 1983, accompanied by a similar growth in the number of S/E employees involved in teaching and other activities. Graduate S/E enrollment in doctorate-granting institutions rose 18% during the period 1975-82, with part-time enrollment going up faster than full-time—32% compared to 13%.

Responsible SRS Organizaton:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that the final report will be published by late 1984 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
International S/T Data

Objective:

To provide recent quantitative information on science and technology (S/T) investments and activities in the large research and development (R&D) performing industrialized nations such as France, Japan, West Germany, and the United Kingdom, and to make comparisons with information on the United States.

Method:

In order to obtain the most current data possible, data were obtained through direct contacts with foreign organizations. Other data sources analyzed included foreign national reports and information from the Organisation of Economic Co-operation and Development.

Major Findings:

The United States devotes a higher proportion of its economy to research and development than most industrialized countries. In 1981, the United States spent more on research and development and had more scientists and engineers engaged in research and development than Japan, West Germany, France, and the United Kingdom combined. The United States produces a greater number of doctorate-level natural scientists and engineers than does West Germany or Japan, in terms of both absolute numbers and proportions of total degrees.

The United States also grants a much greater number of natural science and engineering baccalaureates than either of these two countries, although in 1982 Japan graduated more bachelor's-level engineers (74,000) than did the United States (67,000).

Responsible SRS Organization:

Office of the Director/International S/T Studies

Institution/Principal Investigator:

[Intramural]

Availability:

International Science and Technology Data Update (January 1984) is available from SRS/Editorial and Inquiries Unit.

PROJECT:
Resources Supporting Scientific and Engineering Activities at Historically Black Colleges and Universities

Objective:

To report and analyze information on the overall levels of science and engineering (S/E) resources available to historically black colleges and universities (HBC's).

Method:

Data on 107 HBC's in the United States were collected and published by NSF through four annual surveys of academic S/E resources: (1) Survey of Federal Support to Universities, Colleges, and Selected Nonprofit Institutions; (2) Survey of Scientific and Engineering Expenditures at Universities and Colleges;

(3) Survey of Graduate Science and Engineering Students and Postdoctorates; and (4) Survey of Scientific and Engineering Personnel Employed at Universities and Colleges. Data utilized on Federal support and R&D expenditures were as of FY 1975 through 1982, data on graduate S/E enrollment were as of Fall 1975 through Fall 1982, and data on academic S/E employment were as of January 1976 through January 1983.

Major Findings:

Federal obligations to HBC's totaled $515 million in FY 1982, a 22% growth over 1981 in current dollars and a 9% average annual growth over the 1975 level. About five-sixths of the increase in Federal funding of HBC's during the 1975-82 period was for non-S/E programs, mostly for direct student financial assistance. Federal R&D obligations to HBC's totaled $40 million in 1982, up from $24 million in 1975. Separately budgeted R&D expenditures for S/E programs at HBC's totaled $58 million in 1982, a 16% growth in current terms over 1981 and a 15% per-year increase throughout the 1975-82 period. Between 1975 and 1982, graduate S/E enrollment at HBC's grew by 4% per year to a total of 3,500 (less than 1% of the national total). The 7,800 scientists and engineers employed by HBC's in January 1983 accounted for only 2% of the total employed in all academic institutions. Between January 1976 and January 1983, S/E employment at HBC's grew at an average annual rate of 4%.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Resources Supporting Scientific and Engineering Activities at Historically Black Colleges and Universities, Report, NSF 84-332, will be available in fall 1984 from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the December 1983 Addendum to the *Data User Guide*, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:
Science and Engineering (S/E) Personnel, 1984

Objective:

To provide a comprehensive overview of current employment, supply patterns, and the dynamics of the labor market for all U.S. scientists and engineers.

Method:

Analysis is based on data from a coordinated set of SRS surveys and other primary and secondary data sources. The SRS surveys include the Postcensal Survey of Scientists and Engineers, the New Entrants Survey, and the Survey of Doctoral Scientists and Engineers. The report generally is descriptive, with some analytical treatment of data.

Major Findings:

Employment of scientists and engineers increased by 45% between 1976 and 1983, reaching almost 3.5 million. This rate was about three times that for the total U.S. work force and almost twice that for all professional workers. Over this period, employment of scientists increased more rapidly than that of engineers (5.8% versus 3.6%). Computer specialists led the increase among scientists and accounted for almost two-fifths of total growth in scientific employment. Women scientists and engineers made significant employment gains over the 1976-83 period, when employment of women increased more than three times as rapidly as men. Despite the increase, women continue to be underrepresented in science and engineering. In 1983, they represented 13% of all employed scientists and engineers, but 44% of all employed persons and 48% of all those in professional occupations. Blacks also made significant employment gains over the 1976-83 period, with employment of black scientists and engineers increasing more than twice as rapidly as whites. Blacks, however, continued to be underrepresented in science and engineering: in 1983, blacks represented 2.4% of scientist and engineer employment, but 9% of total U.S. employment and 6% of total professional employment.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Science and Engineering Personnel: A National Overview, will be available from SRS/Editorial and Inquiries Unit by early 1985.

PROJECT:
Science and Technology Data Book

Objective:

To present annually an overview of the funding, staffing, and impacts of the Nation's scientific and technological activities through a presentation that facilitates rapid comprehension in a convenient format.

Method:

Based on data from SRS surveys and other primary and secondary data sources. Report presents information primarily by graphic means in a pocket-sized publication.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section

Institution/Principal Investigator:

[Intramural]

Availability:

The *Science and Technology Data Book*, Report, NSF 83-318, is available from SRS/Editorial and Inquiries Unit. The next issue will be published early in 1985.

PROJECT:
Science and Technology Resources, 1984

Objective:

To present an overview of U.S. science and technology resources based on the most current information available to NSF.

Method:

Information originated from a series of systematic, regularly recurring surveys of institutions. The data were then aggregated by the four major sectors of the economy and included research and development (R&D) funding by source of funds and performer, character of work (basic research, applied research, and development), and international comparisons.

Topics concerning science and engineering (S/E) personnel included women and minorities, employment trends, S/E labor market balance, and sources of new S/E personnel.

Major Findings:

R&D expenditures in the United States are expected to total an estimated $97.0 billion in 1984, an increase of 12% over the previous year (7% in constant dollars). For 1983, the overall increase in the Nation's R&D expenditures is estimated at 9% (4% in constant dollars).

S/E employment between 1976 and 1981 increased at an annual average of 6% in contrast with the 3% rate for the total work force. The S/E unemployment rate increased to nearly 3% in 1982, but was still substantially below the 9% rate for all workers.

Responsible SRS Organization:

R&D Economic Studies and Scientific and Technical Personnel Studies Sections

Institution/Principal Investigator:

[Intramural]

Availability:

"Defense and Economy Major Factors in 7% Real Growth in National R&D Expenditures in 1984," *Highlights*, NSF 83-316, July 22,1983, and *National Patterns of Science and Technology Resources: 1984*, Report, NSF 84-311, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Science Indicators—1982

Objective:

To present quantitative indicators of the state of science and technology in the United States, supplementing but not supplanting the judgment of policymakers who are faced with specific science and technology issues.

Method:

The report draft was prepared in the SRS/Science Indicators Unit for review by a special committee of National Science Board members. Chapters were reviewed by technical experts, and by research and development (R&D) executives of other Federal agencies, and then issued by the full National Science Board.

Major Findings:

Science Indictors—1982 is the sixth in a series of similar reports by the National Science Board. It presents statistical indicators with relevant interpretation and explanation. It is organized into seven chapters:

1. International Science and Technology
2. Support for U.S. Research and Development
3. Science and Engineering Personnel
4. Industrial Science and Technology
5. Academic Science and Engineering
6. Public Attitudes Toward Science and Technology
7. Advances in Science and Engineering

This report contains one chapter (number 5) that was not part of the previous *Science Indicators* reports.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

[Intramural]

Availability:

Science Indicators—1982, is available from the Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20402, and from the Publications Office, Room 232, National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550.

PROJECT:
U.S. Scientists and Engineers, 1982

Objective:

To provide estimates of the U.S. population of scientists and engineers, as well as of their demographic, education, and employment characteristics.

Method:

The results of several surveys conducted by the NSF Scientific and Technical Personnel Data System are being synthesized to produce estimates as of mid-1982.

Major Findings:

Of the 3.1 million employed scientists and engineers in 1982, 1.3 million (41%) were scientists and almost 1.8 million (59%) were engineers. Among scientists, about one-half were either life scientists or computer specialists. A majority of both scientists (52%) and engineers (77%) were employed in business and industry in 1982; educational institutions employed almost 25% of the scientists but only 5% of the engineers. In 1982, about 12% (360,000) of all employed scientists and engineers were women. About 1 in 5 scientists was female compared to about 1 in 20 engineers. Blacks (70,000) represented over 2% and Asians (125,000) about 4% of all employed scientists and engineers. In addition, there were about 70,000 Hispanic scientists and engineers were employed in 1982 (2%) of the total. The baccalaureate was the highest degree earned by over three-fifths of the engineers and slightly less than one-half of the scientists. About 23% of the scientists and 3% of the engineers held the doctorate.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Science and Engineering Jobs Grew Twice as Fast as Overall U.S. Employment with Industry Taking the Lead," *Highlights*, NSF 84-319, June 25, 1984, and, *U.S. Scientists and Engineers: 1982*, Detailed Statistical Tables, NSF 84-321, available from the SRS/Editorial and Inquiries Unit.

PROJECT:
Women and Minorities in Science and Engineering

Objective:

To present a factual picture of the current situation and recent trends in the participation of women and minority group members in science and engineering (S/E) employment and training. The report, the second in a biennial series, is required under Public Law 96-516.

Method:

Based on data from SRS surveys and other primary and secondary data sources. Report is primarily factual, with some analytical treatment of the data.

Major Findings:

Both women and minorities made substantial gains in S/E employment between 1972 and 1982, but they were still underrepresented in most S/E fields. Employment of women scientists and engineers jumped 200% to 437,000 or 13% of all scientists and engineers, but they made up 45% of the total U.S. labor force. Women constituted about 25% of all scientists but only 5% of all engineers. One-fifth of the women, compared with one-third of the men, cited management or administration as their primary work activity. Almost two-thirds of the women, compared with slightly over one-third of the men, had less than 10 years of professional experience in 1982. Blacks accounted for 2.6% of all scientists and engineers, compared to the 6% level found in other professions. Asians represented 4.5% of all employed scientists and engineers, but made up 1.6% of the total U.S. labor force. Asians and whites were more likely to be engineers and computer specialists, and blacks were more likely to be social scientists.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Women and Minorities in Science and Engineering, Report, NSF 84-300, is available from the SRS/Editorial and Inquiries Unit.

section II. human resources

a. characteristics

PROJECT:
Comparative Trends in Academic Abilities of Doctorates in Science, Engineering, and Other Professions

Objective:

To determine if persons of high academic ability and potentially high productivity are choosing careers in professions at the expense of the sciences or engineering.

Method:

Scholastic Aptitude and American College Testing scores of persons who received science and engineering doctorates during the past 15 years will be compared to those for persons receiving doctorates in the humanities, or degrees in business, law, and medicine. The 15-year time frame of the study will allow for the analysis of data reflecting a variety of labor market conditions for new doctorates.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Rutgers State University/Rodney T. Hartnett

Availability:

Expected to be published in fall 1984 and to be available from SRS/Editorial and Inquiries Unit.

PROJECT:
Comparisons, by Sex, of Tasks and Earnings of Scientists and Engineers

Objective:

To improve the methods used in analyzing the gender-related salary differences for workers.

Method:

The study will examine the entrants to the labor market during the 1970's using survey data collected for NSF. It will compare the earnings of women with those of their male counterparts by age, employment, and education, identifying the reasons women opt to enter these fields, and examine the differences in job activities of women and men working as scientists and as engineers.

Major Findings:

Earning differentials are fairly constant, suggesting that both new male entrants and experienced male scientists and engineers earn more than their female counterparts.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS)/ Utilization Studies Group

Institution:

Center for Naval Analysis/Aline Quester

Availability:

Publication of the final report, *Men and Women in Science and Engineering Occupations*, is expected in fall 1984. For further information, contact SRS STPSS/Utilization Studies Group.

PROJECT:
The Doctorate Survey

Objective:

To collect information on characteristics and work plans of new science and engineering (S/E) doctorates through the Survey of Earned Doctorates and to maintain the computerized Doctorate Records File, which is virtually a complete listing of about 760,000 students who have received their doctorates since 1920.

Method:

Questionnaires are distributed to all individuals receiving doctorates, and are completed by them near the time of graduation. In recent years, response rates have been better than 95%. Nonrespondents to the questionnaires are represented in the data base through information obtained from public records such as official commencement programs. Information is collected on demographic characteristics, educational history, sources of financial support for graduate study, and plans for postdoctoral study or employment.

Major Findings:

About 17,900 S/E doctorates were awarded in 1983, 1.8% more than in 1982. Although there were 6% fewer degrees in 1983 than in the peak year of 1973, the increase over 1982 continues the slow uptrend that began in 1979 and indicates a reversal of the pattern of declines that occurred between 1973 and 1978. S/E doctorates were 875 greater in 1983 than in 1978, and the growth was attributable to an increase of 1,155 in degrees earned by women, and by an increase of 820 in degrees earned by non-U.S. citizens with temporary visas. Women received about 4,470 S/E degrees in 1983, 25% of the total. Engineering doctorate production increased for the third consecutive year, with an increase from 2,640 in 1982 to 2,780 in 1983, but was still well below the 1972 peak of 3,500. The share of engineering doctorates awarded to U.S. citizens continued the decline

from 67% in 1972 to 44% in 1983. S/E doctorates accounted for 57% of total 1983 doctorate production.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

National Academy of Sciences/Peter D. Syverson

Availability:

Science and Engineering Doctorates: 1960-82, Detailed Tables and Charts, NSF 83-328, and "Women and Non-U.S. Citizens Responsible for Increase in Production of Science and Engineering Doctorates in 1983," *Highlights*, NSF 84-328, September 26, 1984, available from SRS/Editorial and Inquiries Unit. *Summary Report, 1983. Doctorate Recipients From United States Universities* is available from the Commission on Human Resources, National Research Council, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, and will be available from the National Technical Information Service, Springfield, Virginia 22161.

PROJECT:
Foreign National Scientists and Engineers in the U.S. Labor Force

Objective:

To analyze data about foreign nationals who study science and engineering in the United States and remain to work or who enter the United States after receiving their degrees in other countries. Since the late 1960's, many foreign nationals migrated to the United States to study and work as scientists and engineers, but no definitive data about the trends or levels of this migration exist.

Method:

Results from a variety of surveys will be used to examine this question: NSF Surveys of Doctorate Recipients, the NSF Postcensal Surveys of Scientists and Engineers, and the NSF Surveys of Recent Science and Engineering Graduates. Information will also be obtained from Social Security Administation records to determine the extent of continuing employment of foreign nationals who earned doctorates in the United States.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS)/ Utilization Studies Group

Institution/Principal Investigator:

Oak Ridge Associated Universities/Michael G. Finn

Availability:

Results are expected in summer 1985. For information, contact STPSS/Utilization Studies Group.

PROJECT:
A Guide to Data on Scientific and Engineering Personnel in the United States

Objective:

To produce a guide to the various sources of data on scientists and engineers in this country. It is aimed at those not familiar with the data and who have neither the time nor resources to investigate thoroughly the multitude of information about the characteristics of scientists and engineers.

Method:

The project compares data from NSF, other Federal agencies, and professional societies, detailing the dates of surveys, composition of populations covered, definitions of field and occupation, and similar aspects. The project was conducted with the assistance of the data producers in the associations and agencies.

Major Findings:

The 288-page guide consists of three indexes (bibliographic, by field, and by year) to data collected and published by 49 organizations. The Bibliographic Index is organized alphabetically by agency/society, and gives the name, address, and telephone number of a contact person for each. The function of the publishing organization is described, as are its surveys and each of its publications since 1973 that include data on scientists and/or engineers.

The Field Index is in the form of a matrix, on which data characteristics are listed vertically and publication numbers from the Bibliographic Index horizontally for each of 26 science and engineering fields. Likewise, the Year-of-Data Index is in the form of a matrix and gives the same information for each of 10 years. These indexes provide a quick summary of all available published data characteristics for the field or year in question.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Scientific Manpower Commission/Betty M. Vetter

Availability:

Guide to Data on Scientists and Engineers is available from the Scientific Manpower Commission, 1776 Massachusetts Avenue, N.W., Washington, D.C. 20036.

PROJECT:
New Entrants to Science and Engineering, 1982

Objective:

To obtain the professional, employment, and education characteristics of recipients of bachelor's and master's degrees in science and engineering in the classes of 1979/80 and 1980/81.

Method:

A two-stage sampling plan was utilized to identify a sample (22,000) of science and engineering (S/E) bachelor's and master's recipients. The first stage sampled the universe of those institutions of higher education that grant S/E degrees. The second stage sampled the graduates of the institutions selected in the first stage. The selected individual graduates received a mail questionnaire during the summer and fall 1982. The data collection focused on education, employment, and professional characteristics.

Major Findings:

The 1980 S/E graduates experienced greater difficulty in finding employment in 1982 than had the 1978 S/E graduates in 1980. Two years following their graduation, the classes of 1978 and 1980 reported 3.1% and 5.5% unemployment rates, respectively. Unemployment rates for computer specialists, engineers, and economists were less than 2.0%. The demand for computer specialists continued to exceed the supply of graduates in that field. Only about two-fifths of the 1980 S/E graduates employed as computer specialists had received their degrees in computer science. Another two-fifths had received their baccalaureates in mathematics/statistics. Women with recent S/E bachelor's degrees were almost as likely as men to be employed in 1982, 92% versus 95%. The comparable rates in 1980 were 96% and 97%.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Temple University/Koray Tanfer

Availability:

Characteristics of Recent Science/Engineering Graduates: 1982, Detailed Statistical Tables, NSF 84-318, and "1982 Job Market for New Science and Engineering Graduates About the Same as That of Previous Years," *Highlights*, NSF 84-310, April 30, 1984, available from SRS/Editorial and Inquiries Unit.

PROJECT:
1982 Postcensal Data on Scientists and Engineers

Objective:

To obtain the professional, employment, and education characteristics of individuals in selected occupations included in the 1980 Decennial Census.

Method:

A sample of individuals (150,000) was drawn from the 1980 Census of Population and Housing for selected occupations. This sample was stratified in terms of sex and race. The members of the sample received a mail questionnaire in the spring of 1982. The data collection focused on education, employment, and professional characteristics of respondents.

Major Findings:

Of the approximately 3.5 million scientists and engineers in the United States in 1982, information on about 1.9 million individuals was obtained from the 1982 Postcensal Survey of Scientists and Engineers. These 765,000 scientists and 1,145,000 engineers represent a large proportion of the Nation's *experienced* science and engineering population. Employment of scientists and engineers increased more than twice as rapidly as total U.S. employment over the 1972-82 decade (50% versus 20%) and varied considerably by field with the number of scientists increasing more rapidly than engineers (75% and 37%, respectively). During the same decade, employment of women and racial minorities increased more rapidly than employment of men and the majority. For women, the increase was over 200%; for men, 40%; for minorities, over 200%; and for whites, about 40%. Research and development, including R&D management, was the primary work activity of almost 40% of the employed scientists and engineers in 1982. About 20% were engaged in management activities (excluding R&D management), and about 8% were primarily engaged in teaching.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Bureau of the Census/John Keane

Availability:

The 1982 Postcensal Survey of Scientists and Engineers, Detailed Statistical Tables, NSF 84-330, will become available from SRS/Editorial and Inquiries Unit in Winter 1985.

PROJECT:
Survey of Doctorate Recipients

Objective:

To obtain the professional, employment, and education characteristics of the Nation's science and engineering (S/E) doctorate population.

Method:

A sample (50,000) of S/E doctorate holders who received their degrees during the period 1940-82 was drawn from the Doctorate Roster. The resulting individuals received a mail questionnaire during the spring of 1983. The information-collection phase will terminate at the end of the calendar year.

Major Findings:

In 1983, the number of employed doctoral scientists and engineers in the United States reached 369,000. Employment of doctoral scientists and engineers in industry increased sharply between 1981 and 1983 (about 15% versus 7.5% for all sectors combined), continuing a trend that began in the early 1970's. Academic employment grew at little more than half the rate of industrial employment during the 1973-83 decade, and Federal Government employment grew even more slowly. As a result, by 1983 industry's share of the doctoral employment of scientists and engineers was 31%, the academic share was 53%, and the Federal Government share was 7%. Employment of computer specialists increased at three times the average rate (16.3% per year versus 5.3% per year) between 1973 and 1983. The social sciences and psychology grew at higher than average rates during this period, while physical and mathematical sciences grew at slower rates. Women and minority doctoral scientists and engineers showed strong employment gains between 1973 and 1983, an average annual growth rate of 11.2% for women and 9-13% for blacks, Asians, and Hispanics.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

National Academy of Sciences/Betty D. Maxfield

Availability:

Characteristics of Doctoral Scientists and Engineers in the United States: 1983, Detailed Statistical Tables; publication is expected by early 1985, and will be available from SRS/Editorial and Inquiries Unit.

section II. human resources

b. education

PROJECT:
The Effect of Departmental Quality Changes in Graduate Student Enrollment and Support

Objective:

To determine whether there have been differential changes in patterns of enrollment, sources of student support, and doctoral output among research doctorate departments of varying quality. In addition to an examination of trends in sources and types of support, particular attention will be given to trends in Federal vis-a-vis the availability of alternative sources.

Method:

This project will link for the first time the NSF Survey of Graduate Science Students and Postdoctorates and the National Research Council's (NRC's) Survey of Earned Doctorates with the NRC Assessment of Quality-Related Characteristics of Research Doctorate Programs in the United States. Tables will be produced to permit the analysis of enrollments and student support for full-time students in doctorate-granting departments by field of science, public and private institutional control, and departmental quality rating. In addition, tables will be produced documenting trends in Ph. D. production by field and program quality, length of time between registration and degree conferral, and postdoctoral employment plans. Data will be analyzed for the period 1974-82.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Council of Graduate Schools in the United States/Robert G. Snyder

Availability:

Graduate Science and Engineering Enrollment and Support by Departmental Quality: 1974-82, Final Report, to become available late in 1984 from SRS/Science Indicators Unit.

PROJECT:
Engineering Programs in Emerging Areas, 1983-84

Objective:

To obtain information about doctoral programs in emerging engineering areas, which include biotechnology, robotics, microelectronics, and materials and manufacturing. Data were requested on the number of emerging programs in each college of engineering, the number of faculty by academic rank, faculty recruitment efforts, and number of graduate students pursuing doctorates in the emerging areas.

Method:

The survey is being conducted by the Higher Education Panel of the American Council on Education. The Panel includes a stratified sample of universities and colleges. The questionnaire was mailed in June 1984 to 135 institutions that award the doctorate in engineering.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

American Council on Education/Frank J. Atelsek

Availability:

The survey report is expected to be available in early 1985 from the Higher Education Panel, American Council on Education, One Dupont Circle, N.W., Washington, D.C. 20036.

PROJECT:
Graduate Science and Engineering (S/E) Enrollment, 1982

Objective:

To provide quantitative information by discipline on the characteristics of graduate S/E students and postdoctorates, with emphasis on their sources of support.

Method:

All graduate S/E departments in 291 master's- and 324 doctorate-granting institutions received the annual questionnaire for fall 1982 data. There were several elements: Major sources and types of full-time graduate students' support, graduate enrollment status (full- or part-time), level of study, citizenship, sex, and racial/ethnic origin. Data were also collected on support patterns of postdoctorates and on nonfaculty doctoral research staff; an optional sheet requested data on faculty rank, new hires, and departures during the previous academic year. The survey was closed out in August 1983, with 89% of the institutions responding.

Major Findings:

S/E graduate enrollment reached 400,000 in fall 1982, up 2% from the fall 1981 total. Over one-half of the 1981-82 increase

occurred in engineering, which constituted 22% of all S/E graduate enrollment. The computer sciences continued to be the fastest growing science field, up 20% from 1981. A 7% decline in the number of full-time students relying primarily on the Federal Government for support was offset by increases in the numbers supported by other sources. The number of foreigners grew by 5%, down from the 10% average annual growth rate of recent years, while the number of U.S. citizens remained level.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Graduate Science/Engineering Enrollment Grew by 2% Between Fall 1981 and 1982, With Computer Sciences, Up 20%, Leading Growth," *Highlights*, NSF 84-313, May 31, 1984, and *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1982*, Detailed Statistical Tables, NSF 84-306, are available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the December 1984 Addendum to the *Data User Guide*, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:
Graduate Science and Engineering (S/E) Enrollment, 1983

Objective:

To provide quantitative information by discipline on the characteristics of graduate S/E students and postdoctorates, with emphasis on their sources of support.

Method:

All graduate S/E departments in 290 master's- and 324 doctorate-granting institutions received the annual questionnaire for fall 1983 data. There were several data elements: Major sources and types of full-time graduate students' support, graduate enrollment status (full- or part-time), level of study, citizenship, sex, and racial/ethnic origin. Data were also collected on support patterns of postdoctorates and on nonfaculty doctoral research staff, and on full-time S/E faculty by rank and tenure status, with new hires and departures during the previous academic year. The survey was closed out in August 1984.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that Detailed Statistical Tables will be published early in 1985 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
Plant Biology Training and Personnel

Objective:

Plant biology has been identified and recommended as a research area that is likely to return high scientific dividends as a result of increased financial support. Planning for a major emphasis, however, requires the collection of data not previously available about plant biology programs in higher education, including the numbers and specialties of faculty, postdoctorates and graduate students, amount and sources of support, and other related matters.

Method:

The survey was conducted by the Higher Education Panel of the American Council on Education. The Panel includes a stratified sample of universities and colleges. The questionnaire was mailed in October 1983 to 210 doctorate-granting institutions, and an 87% response rate was obtained.

Major Findings:

Expenditures for plant biology research at doctorate-granting institutions in fiscal year 1983 were about $200 million. The Federal Government provided one-half of the support and State Governments provided one-third. In fall 1983, graduate plant biology programs were reported in 165 institutions. These programs involved 4,600 full-time faculty members, 8,000 full-time graduate students, and about 1,000 postdoctorate fellows and associates. Plant biology full-time graduate students constituted 18% of all full-time graduate students in agriculture and biological sciences. In 1982-83, about 925 doctorates were awarded in plant biology. Plant biology training and research were concentrated in the land-grant institutions. They received 83% of the total research support and employed 80% of the faculty in the field. They also trained 80% of the graduate students and doctorate recipients. Thirty percent of the graduate students were women, and 20% were non-U.S. citizens on temporary visas. Three-fourths of the latter were from developing countries.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

American Council on Education/Frank J. Atelsek

Availability:

"1983 Plant Biology Research Expenditures Totaled $200 Million and Were Concentrated in Land-grant Institutions," *Highlights*, NSF 84-327, September 27, 1984, available from SRS/Editorial and Inquiries Unit and "Plant Biology Personnel and Training at Doctorate-Granting Institutions," *Higher Education Panel Report*, No. 62, available in late 1984 from the Higher Education Panel, American Council on Education, One Dupont Circle, N.W., Washington, D.C. 20036.

PROJECT:
Quality of Undergraduate and Graduate Students in Selected Science and Engineering (S/E) Fields

Objective:

To obtain information on changes in the quality of S/E students compared to (a) previous cohorts of S/E students and (b) current students in other fields.

Method:

The survey was conducted by the Higher Education Panel of the American Council on Education. The Panel includes a stratified sample of universities and colleges. The questionnaire was mailed in 1982 to 486 institutions with undergraduate programs and 383 institutions with graduate programs. The response rates were 80% and 78%, respectively. Weighted estimates were developed to represent all institutions at each degree level.

Major Findings:

A majority of senior academic officials believe that there has been no significant change in the quality of S/E students over the past five years. Sixty percent reported "no change" in quality of S/E undergraduate or graduate students. Although the majority of those queried indicated no change, most of the rest expressed views that point toward quality improvement. Officials at many institutions reported a shift of the most able undergraduate students toward S/E fields. Officials attributed this shift primarily to changes in perceptions about employment opportunities following receipt of the bachelor's degree. The graduate deans compared the quality of 1981/82 S/E doctorate recipients with those of 1976/77. The two groups were perceived by 66% of the deans to be equally qualified, but those who observed a quality difference generally favored the 1981/82 group.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Supply and Education Analysis Group

Institution/Principal Investigator:

American Council on Education/Frank J. Atelsek

Availability:

"No Change in Science and Engineering Student Quality Seen by 60% of Academic Officials: At Least 25% Perceive Improvement," *Highlights*, NSF 83-322, September 30, 1983, available from SRS/Editorial and Inquiries Unit, and "Student Quality in the Sciences and Engineering: Opinions of Senior Academic Officials," *Higher Education Panel Report*, No. 58, available from the Higher Education Panel, American Council on Education, One Dupont Circle, N.W., Washington, D.C. 20036, and from the National Technical Information Service, Springfield, Virginia 22161, PB 84-196252, $10.00 (paper copy), $4.50 (microfiche).

PROJECT:
The Relation Between Education and Professional Practice in Science, Engineering, and Public Policy

Objective:

To determine (1) if education for the emerging fields of science, engineering, and public policy (SEPP) is relevant and adequate; and (2) how this education can be made more responsive to employer requirements.

Method:

The project will survey SEPP departments in approximately 35 universities, their graduates, and others employed in SEPP positions. It will seek information about the relationship between course offerings and job content of workers in the SEPP fields.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS) / Utilization Studies Group

Institution/Principal Investigator:

American Association for the Advancement of Science/Albert H. Teich

Availability:

A report is expected in the spring of 1985. For information on obtaining the report, contact STPSS/Utilization Studies Group.

PROJECT:
The Relation of Precollege Education in Mathematics and Science to Achievement and College Major

Objective:

To determine if there is a correlation between precollege education in science and mathematics, and the choice of a major and academic performance in college.

Method:

This study will relate precollege achievement-score data from the National Assessment of Educational Progress to data on characteristics of students and their schools that were collected from the high school classes of 1972 and 1980. The samples queried by the latter surveys, the National Longitudinal Survey of 1972 and the High School and Beyond Survey of 1980, have been resurveyed periodically to obtain information on education and employment following high school graduation.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS) / Utilization Studies Group

Institution/Principal Investigator:

University of North Carolina/Lyle Jones

Availability:

Results are expected in August 1985. For further information, contact STPSS/Utilization Studies Group.

PROJECT:
Selected Indicators from the Annual Survey of American College Freshmen

Objective:

To produce a set of summary tables from the Higher Education Research Institute's annual survey of first-time, full-time freshmen in four-year colleges and universities.

Method:

Survey information will be summarized for a selected number of questions drawn from the annual survey of American college freshmen using weighted national norms for all first-time, full-time freshmen attending four-year colleges and universities. Tables will draw on student responses by sex and by racial/ethnic group to questions addressing probable major, high school grade-point averages, anticipated need for tutoring/remedial work, parental education, and importance of certain life goals. Comparisons will be made across probable fields of study.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Higher Education Research Institute, UCLA/Kenneth C. Green

Availability:

Tabulations will be available for inspection in late 1984 in the SRS/Science Indicators Unit.

section II. human resources

c. employment

PROJECT:
Academic Employment of Scientists and Engineers, 1983

Objective:

To provide annual quantitative information on professional science and engineering (S/E) personnel employed by universities and colleges.

Method:

Coordinators in 2,200 institutions with S/E programs received the questionnaire for the January 1983 survey. Data elements were level of educational attainment, discipline of employment, employment status (full- or part-time), sex, and total and R&D full-time-equivalents. Responses were received from 82% of the doctorate-granting institutions, where two-thirds of the S/E professionals were employed. The survey was closed out in August 1983.

Major Findings:

S/E employment in the higher education sector continued to climb in 1983 to approximately 359,000, a 3% rate of increase over 1982. Over 20% of the academic S/E work force was employed part time. The sharpest rise occurred in the computer sciences, up 16% from 1982 to 1983.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Science and Engineering Employment in Academia Grew 3% in 1983," *Highlights*, NSF 84-317, May 23, 1984, available from SRS/Editorial and Inquiries Unit, and *Academic Science/Engineering: Scientists and Engineers, January 1983*, Detailed Statistical Tables, NSF 84-309, National Technical Information Service, Springfield, Virginia 22161; also available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the Addendum to the *Data User Guide*, December 1983, available from the RDESS/Universities and Nonprofit Insititutions Studies Group.

PROJECT:
Academic Employment of Scientists and Engineers, 1984

Objective:

To provide annual quantitative information on professional science and engineering (S/E) personnel employed in universities and colleges.

Method:

Coordinators in a sample of 1,100 institutions with S/E programs received the questionnaire for the January 1984 survey. Data elements were level of educational attainment, discipline of employment, employment status (full- or part-time), sex, and total and R&D full-time-equivalents.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that Detailed Statistical Tables will be published by summer 1985 and will be available from SRS/Editorial and Inquiries Unit.

PROJECT:
Analysis and Dissemination of Data on Supply/Demand Balances of Engineering College Faculty

Objective:

To provide information on the current shortages in engineering faculty. To explore the effectiveness of various initiatives by industry, Government, and academe to increase the pool of engineering doctorate candidates and to make teaching more attractive than it has been to the young doctorate.

Method:

A fall 1983 survey of a representative sample of engineering deans at schools offering bachelors of higher degrees in engineering collected data about unfilled faculty positions. This information will be compared to similar data collected during 1981-83 to determine trends in faculty shortages by engineering discipline. The information will be broken down by geographic region and public versus private institutions.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS) / Utilization Studies Group

Institution/Principal Investigator:

American Society of Engineering Education/Edward Lear

Availability:

Results are expected in fall 1984. For further information contact STPSS/Utilization Studies Group.

PROJECT:
Developing New Indicators of Input into Science and Technology

Objective:

To test the utility of state-of-the-art survey research methods to generate indicators of the participation of university and college science and engineering (S/E) faculty in paid, private, off-campus consulting and R&D work. Another issue to be explored is the hypothesis that college university S/E faculty who engaged in off-campus consulting and research and development play a particularly strong role in small, innovative industrial firms.

Method:

The study will be limited to full-time S/E faculty at doctoral/research institutions and comprehensive colleges and universities (as classified by the Carnegie Council in 1976 and as updated by the National Center for Education Statistics in 1980). A total of 1,200 scientists and engineers will be interviewed by telephone regarding the nature and extent of paid, private, off-campus consulting and R&D work during 1984. A subsample of these scientists and engineers will be interviewed in person to validate the findings from the telephone interviews. In addition, a limited number of interviews with off-campus employers of faculty consultants is planned to generate additional information regarding the validity of faculty respondents' statements about the nature of their contributions.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Foundation of California State University, Sacramento/Frank Darknell

Availability:

Final report is expected in Spring 1985.

PROJECT:
Employment of Doctoral Scientists and Engineers in Business and Industry

Objective:

To provide a set of summary tables from the biennial Survey of Doctorate Recipients showing the distribution of doctoral scientists and engineers in business and industry by industry group and field of doctorate.

Method:

Survey information will be grouped by field of doctorate for all doctoral scientists and engineers employed in business and industry in 1973 and 1983. Survey information will be provided for all respondents using the Standard Industrial Classification system, and analyzed for selected Ph. D. cohorts.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

National Research Council/Betty D. Maxfield

Availability:

Tabulations will be available for inspection in late 1984 in the SRS/Science Indicators Unit.

PROJECT:
The Qualities of Occupationally Mobile Scientists and Engineers

Objective:

Employers of scientists and engineers historically fill many vacancies with in-mobile workers rather than with new graduates whose degrees are in a field directly related to the occupation. This study seeks answers to questions about the qualitative functioning of the mobility process, including the extent of upgrading or transfer of workers from other occupations, the rate at which workers with previous experience in the occupation return, and the education and training necessary for each such group.

Method:

The study will present the results of tabulations, as well as correlation and regression analysis of the various measures by occupation and mobility status. Three data sources will be examined: the NSF Experienced Sample Surveys for 1972, 1974, 1976, and 1978; the 1982 Postcensal Survey; and data

from the Current Population Surveys for 1973, 1978, 1981, and 1983.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS)/ Utilization Studies Group

Institution/Principal Investigator:

Oak Ridge Associated Universities/Robert DauffenBach

Availability:

Results are expected in FY 1985. For further information contact STPSS/Utilization Studies Group

PROJECT:
A Rapid Industry Limited-Response Survey Panel on Scientific and Engineering (S/E) Personnel Resources

Objective:

To acquire and disseminate information on the industrial labor market for S/E personnel so that policy can be formulated rapidly to meet urgent needs.

Method:

SRS established an industry panel of company representatives whose opinions and access to information can provide qualitative and quantitative information that is not readily available on a timely basis from any other source.

Major Findings:

The first survey, conducted in the fall of 1981, sought to identify the extent of reputed shortages of scientists and engineers. The survey found definite and likely shortages of persons trained in computer science; systems analysis; and electrical/electronics, petroleum, and computer engineering. In a followup survey in the summer of 1982, over 50% of the firms indicated that it had become easier to hire new scientists and engineers. The only field where as much as 40% of employers reported shortages was electronics engineering at the master's-degree level. In a similar survey conducted in August 1983, a short supply was not reported for a single S/E field by more than 10% of the surveyed companies.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Labor Markets for New Science and Engineering Graduates in Private Industry," *Highlights*, NSF 82-310, June 9, 1982; "Labor Market Slackens for New Science and Engineering Graduates," *Highlights*, NSF 82-330, November 22, 1982; and "Industry Reports Shortages of Scientists and Engineers Down Substantially From 1982 to 1983," *Highlights*, NSF 84-303, February 17, 1984, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Scientists, Engineers, and Technicians in Private Industry

Objective:

To provide data on employment of scientists, engineers, and technicians in the private sector by occupation and industry of employment.

Method:

Annual surveys of employing establishments are conducted by State Employment Security Agencies in cooperation with the Bureau of Labor Statistics. The State data are combined into national estimates of employment by Standard Industrial Classification (SIC) code. This is an ongoing survey that began in 1977. Each year one of three subsectors (manufacturing, trade and regulated industries, or other nonmanufacturing) is surveyed.

Major Findings:

Findings for establishments in manufacturing industries represented within SIC categories 20-39 indicate that employment of scientists, engineers, and technicians in manufacturing industries grew between 1977 and 1980, more than six times as fast as that of the overall work force– 6% per year reaching 1,345,000. Most of this growth was generated by high-technology industries—electrical and nonelectrical machinery, transportation equipment, chemical, and instruments. Most manufacturing industries increased the share of their work force that consisted of scientific, engineering, and technical personnel. Those types of increases, as opposed to overall employment growth, accounted for 85% of the growth of scientists, engineers, and technicians.

Establishments in nonmanufacturing industries represented within SIC categories 10-17, 60-67, and 70-89 include mining, contract construction, finance, insurance, real estate, and service industries. Science, engineering, and technican (SET) occupations in these nonmanufacturing industries grew more than

twice as fast as the overall work force between 1977 and 1981—8.4% versus 3.4% per year. Most of this growth was concentrated within the business service and miscellaneous service industries and was related not to industrial expansion, but to the growing share of jobs being filled by SET personnel. Changes in staffing patterns accounted for more than half of the growth in SET employment over this period.

The project also reports findings for establishments in trade and regulated industries represented in SIC categories 41, 42, and 44-59 that include transportation, communications, utilities, and trade. SET employment grew faster than the total work force in these industries between 1979 and 1982: 6.3% versus 0.4% per year. Most growth in SET employment in trade and regulated industries resulted primarily from increased utilization of these personnel relative to that of other workers.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Scientists, Engineers, and Technicians in Manufacturing and Nonmanufacturing Industries: 1980-81, Detailed Statistical Tables, NSF 83-324; "Manufacturing Employment Becomes Increasingly Technological," *Highlights*, NSF 83-303, March 10, 1983; "Technical Employment Growth Accelerates in Selected Nonmanufacturing Industries," *Highlights*, NSF 83-321, October 17, 1983; *Scientific and Technical Work Force in Trade and Regulated Industries Shows Major Shift in Occupational Composition: 1979-82*, Report, NSF 84-323, May 1984, available from SRS/Editorial and Inquiries Unit; and *Changing Employment Patterns of Scientists, Engineers, and Technicians in Manufacturing Industries: 1977-80*, Final Report, NSF 82-331, October 1982, National Technical Information Service, Springfield, Virginia 22161, PB 83-210690, $10.00 (paper copy), $4.00 (microfiche), also available from SRS/Editorial and Inquiries Unit.

section II. human resources

d. projections

PROJECT:
Attributes of Successful Engineering Students

Objective:

To determine whether engineering students' precollege attributes, including aptitudes, attitudes, and experiences, can be used as a basis for predicting the likelihood of their success in completing academic programs. Should the findings be positive, knowledge of such attributes would than be a tool by which to identify those applicants who are most likely to complete their education and those most likely to require tutorial aid.

Method:

This study will link data from two prior surveys that examined the experiences, aptitudes, interests, and other attributes of engineers and of engineering students. These data on the characteristics of recent graduates will be applied to survey data about the precollege interests, activities, career plans and abilities of beginning engineering students to ascertain the characteristics of students most likely to complete engineering programs. The study will control for sex and race factors, and will develop profiles of those students who are most likely to become engineers.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS)/ Utilization Studies Group

Institution/Principal Investigator:

Purdue University/William K. LeBold

Availability:

Results are expected in spring 1985. For further information, contact STPSS/Utilization Studies Group

PROJECT:
Computer Model Estimates of the Science and Engineering (S/E) Population

Objective:

To develop and implement a computer model for the production of national estimates of the demographic and employment characteristics of scientists and engineers in the United States using the results of several SRS-sponsored surveys of S/E personnel resources.

Method:

The computer model (SETAB) consists of three sets of routines. The first extracts information from the raw files and creates smaller microdata files that may be processed economically and rapidly. A second set manipulates the survey data by "aging" the data collected in one year to represent a population in a later year or to impute missing information. The third set produces a series of tables consistent in format with previously published NSF data. Data files and methods thus developed are being used to trace changes in the social, demographic, and employment characteristics of scientists and engineers. Among the characteristics that are being quantified are changes in sex and ethnic characteristics, labor force status, occupation, sector of employment, and primary work activity.

Major Findings:

SETAB is being used to produce tabulations for scientists and engineers for 1982 and 1983. Estimates for prior years are being revised on the basis of data from the 1982 Postcensal Survey.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Demographic Studies Group

Institution/Principal Investigator:

Mathematica Policy Research, Inc./David Edson

Availability:

NA

PROJECT:
Demographic and Economic Determinants of Scientific Productivity

Objective:

To study (1) the factors determining individual scientific productivity of doctoral scientists by isolating separately the effects of age, lapse of time since degree receipt or entry into the field's labor market ("vintage"), and cumulative outside influences during the passage of time; and (2) the ramifications of these trends upon potential productivity in science fields vital to the national defense and the economy.

Method:

Econometric modeling will be used to sort the separate effects of age, time of degree receipt, and calendar time on productivity. The study utilizes pooled cross-section, time-series data from the National Research Council's 1973-81 National Surveys of Doctorate Recipients. These surveys contain information on date doctorate was received, age, tenure status, race, sex, identity of doctorate-granting institution, and characteristics of the current employer. Productivity will be measured by the output of publications and will be ascertained by matching the sample population with the *Science Citation Index*.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section (STPSS)/ Utilization Studies Group

Institution/Principal Investigator:

Georgia State University/Paula Stephan

Availability:

Results are expected in the fall 1985. For further information, contact STPSS/Utilization Studies Group

PROJECT:
The Engineering Degree-Conferral Process—Analysis and Projections

Objective:

To develop a series of econometric models that project the supply of new engineering graduates by field of engineering, race, and sex.

Method:

The projections will be both short term (up to five years) and long term, and will be closely related to projections of the economic conditions that affect the market place for engineers, comparing them to past occupational-choice patterns of students.

Major Findings:

NA

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

Engineering Manpower Commission/Patrick Sheridan

Availability:

Results are expected in the fall of 1984.

PROJECT:
Impact of Defense Buildup on the Scientific and Engineering (S/E) Work Force

Objective:

To assess the adequacy of the supply of scientists and engineers to meet the demands generated by the proposed defense buildup over the 1980-86 period.

Method:

The research entails utilization of the Defense Inter-Industry Forecasting System (DIFS) of Data Resources, Inc., to generate employment requirements by detailed occupation and industrial classifications in both the defense and nondefense sectors. Detailed occupational requirements generated by various combinations of defense expenditure patterns and macroeconomic conditions were compared to the projected supply of S/E personnel to identify possible shortages. The projected supply was derived by use of a dynamic simulation model that forecasts degree conferrals, curriculum choice, labor force participation, and occupational mobility. The latter model was developed under NSF support by Drs. Robert DauffenBach (Oklahoma State University) and Jack Fiorito (University of Iowa).

Major Findings:

Shortages representing at least a 10% shortfall in supply are projected for aeronautical/astronautical engineers and computer specialists. By 1987, the shortfall for the former is expected to vary from 15% to 45% representing approximately 10,000 to 35,000 personnel; for the latter, the comparable range is expected to be 15% to 30%, or about 115,000 to 140,000 personnel. At high projected levels of defense expenditures the shortfall of electrical/electronics engineers will be almost 10% of supply, or roughly 30,000 personnel. Increasing job opportunities and wage incentives can be expected to draw workers into these fields, helping to alleviate potential problems.

Projections of scientists, engineers, and technicians (SET) were more sensitive to variations in defense spending than to variations in macroeconomic activity because the former's impact is concentrated on high-technology manufacturing industries. Among SET occupations, defense expenditures have their strongest impact on the engineering work force.

Responsible SRS Organization:

Scientific and Technical Personnel Studies Section/Utilization Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Projected Employment Scenarios Show Possible Shortages in Some Engineering and Computer Specialties," *Highlights*, NSF 83-307, February 23, 1983, and *Projected Response of the Science, Engineering, and Technical Labor Market to Defense and Nondefense Needs: 1982-87*, Report, NSF 84-304, available from SRS/Editorial and Inquiries Unit.

section III. funding of science and technology

a. government

PROJECT:
Federal R&D Funding: The 1975-85 Decade

Objective:

To provide an overview of major trends in Federal support for research and development over a ten-year period.

Method:

Material included in the report is based on an annual survey of all Federal agencies that support R&D programs, and on reports provided annually by agencies to the Office of Management and Budget for the Special Analysis on research and development. Attention is given to Federal R&D funding in the context of total national R&D support, and on Federal funding by agency and character of work, and support to universities and colleges. Also shown are comparisons between support for defense and non-defense R&D activities.

Major Findings:

In 1985, Federal R&D obligations are expected to increase by $6.5 billion over FY 1984, or 14%. Over the 1975-85 decade, growth in 1985 is second only to the 13% increase registered between 1983 and 1984. In constant dollar terms, the 1985 increase of 9% continues a growth pattern started in 1984 that followed flat R&D budgets during the previous eight years. The Department of Defense, with an estimated 22% increase in 1985 R&D obligations, advances more than any other agency, followed by NSF with growth of 14%. Over the 1975-85 decade most of the growth experienced by the Department of Defense has occurred in the latter half.

Responsible SRS Organization:

R&D Economic Studies Section/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal R&D Funding: The 1975-85 Decade, Special Report, March 1984, available from the SRS/Editorial and Inquiries Unit.

PROJECT:
Federal R&D Funding, FY 1983-85

Objective:

To develop comprehensive data and analyses of funding levels for R&D and R&D plant programs of Federal agencies in the 1985 budget. To present data and analyses based on a survey of all agencies sponsoring R&D programs, covering such categories as basic research, applied research, development, performing sectors, fields of science, and geographic (State) distribution.

Method:

The survey is a recurring one, using a questionnaire that is sent annually to all Federal agencies that support R&D programs. Agency subdivisions that respond to the survey are, for the most part, budget offices where records are maintained of past and ongoing program levels and latest budget request levels. Responses to the 1983-85 (Volume XXXIII) survey were received and reviewed by NSF by mid-July 1984. They were processed by computer in the form of 133 detailed statistical tables.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal Funds for Research and Development, Fiscal Years 1983, 1984, and 1985, Volume XXXIII, Detailed Statistical Tables, will be issued in late 1984 and will be available from the National Technical Information Service, Springfield, Virginia 22161, and SRS/Editorial and Inquiries Unit; *Federal Funds for Research and Development, Historical Tables: Fiscal Years 1967-85* is unpublished and will be available gratis by December 1984 from RDESS/Government Studies Group, upon request. A Final Report based on the Volume XXXIII survey will be published early in 1985. *Highlights* will be published late in 1984 and available from SRS/Editorial and Inquiries Unit.

PROJECT:
Federal R&D Programs by Budget Function, FY 1983-85

Objective:

To provide a complete overview of Federal R&D program planning and to offer a record of amounts requested in the 1985 budget. Also to afford a view of R&D amounts as shares of total budget function amounts, and to provide a means of quickly assessing relative priorities given to various R&D functional areas and various R&D programs within the Federal R&D total. To provide a basis for keeping track of subsequent congressional appropriation actions subsequent to the budget presentation.

The report groups approximately 600 R&D programs included in the 1985 Federal budget by budget function. Tables are accompanied by brief descriptions of funding changes for specific programs.

Method:

Sources of funding data were reports provided by the agencies to the Office of Management and Budget for "Special Analysis K: Research and Development" in the 1985 budget, presented in January 1984, plus agency budget justification documents prepared for the Congress, and some information provided informally by some of the smaller R&D support agencies. The data were developed and arranged by budget function by NSF/SRS staff, and descriptions of budget changes were produced from budget documents.

Major Findings:

Total R&D budget authority for all R&D programs, as proposed in the 1985 budget, is $52,660 million, 19% higher than the 1984 total of $44,367 million, allowing for considerable real growth. This increase contrasts with the 10% increase in 1985 budget authority in the overall Federal budget. The 1985 budget represents continued high priority for research and development as relevant to the Nation's long-term well-being. Federal R&D support was targeted especially at national defense and basic research. Within basic research special emphasis was given to the physical sciences and engineering to provide the foundation for the achievements of long-term national objectives of a strong defense and economic security. At the same time, the 1985 budget continues to propose reductions in nearer-term R&D programs that are not considered an appropriate Federal responsibility. These reductions occur in a number of programs and agencies, including nearer-term, technology-development programs within energy and natural resources and environment. R&D priorities, measured in terms of shares of the total held by various functional areas, have continued to shift over the 1983-85 period, with the most dramatic change occurring in national defense. This functional area accounted for 64% of the total in 1983, then grew to 66% in 1984 and 70% in the 1985 budget.

Responsible SRS Organization:

R&D Economic Studies Section/Government Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Federal R&D Funding by Budget Function: Fiscal Years 1983-85, Report, March 1984, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, FY 1982

Objective:

To develop annual data from the Federal agencies believed to fund the largest programs in support of academic science/engineering (S/E) activities, particularly research and development.

Method:

Fifteen agencies received instruction booklets and institutional Code Books defining the obligations and disciplines concerned for FY 1982. There were four data elements: Agency, academic institution, discipline, and activity (research and development, R&D plant, facilities/equipment, fellowships/traineeships/training grants, general S/E support, and other S/E and non-S/E activities). The survey was closed out June 1983.

Major Findings:

Obligations from Federal agencies to universities and colleges from FY 1981 to FY 1982 increased by 13% (5% in constant 1972 dollars), in contrast to a 7% decrease (15% in constant dollars) from FY 1980 to FY 1981. Funding for non-S/E programs largely made up of direct student financial assistance, increased by 23% in real-dollar terms, but R&D support from 1981 to 1982 declined by nearly 4% in real dollars.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Federal Academic Obligations Increased by 13% in 1982, 5% in Real Dollars," *Highlights*, NSF 84-305, April 26, 1984, available from SRS/Editorial and Inquiries Unit; *Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1982*, Final Report, NSF 84-315, July 1984, will be available from National Technical Information Service, Springfield, Virginia 22161, and is available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the *Data User Guide* and Addendum, December 1983, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:
Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, FY 1983

Objective:

To develop annual data from the Federal agencies believed to

fund the largest programs in support of academic science/engineering (S/E) activities, particularly research and development.

Method:

Fifteen agencies received instruction booklets and institutional Code Books defining the obligations and disciplines concerned for FY 1983. There were four data elements: Agency, academic institution, discipline, and activity (research and development, R&D plant, instructional facilities/equipment, fellowships/traineeships/training grants, general S/E support, and other S/E and non-S/E activities). The survey was closed out in June 1984.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

The Final Report for FY 1983 will include Detailed Statistical Tables, and it is anticipated that this report and the *Highlights* for FY 1983 will be published in summer 1985. It will be available from SRS/Editorial and Inquiries Unit.

section III. funding of science and technology

b. industry

PROJECT:
Developing Strategies for Augmenting Response to the NSF Industrial R&D Survey

Objective:

To learn whether the response rate to NSF's annual survey of industrial research and development can be improved by analyzing the decision-making processes by which firms determine the extent of their participation in nonmandatory Government surveys.

Method:

The project included onsite and telephone discussions with company officials (of randomly selected major R&D-performers) responsible for setting corporate policy on response to Government surveys. Based on these discussions, TARP, Inc., identified four models of the decision-making process, developed strategies designed to motivate decision makers to encourage their companies' full participation in the survey, and tested these strategies to determine if the response rate could be improved.

Major Findings:

Several deterrants to response were identified including unavailability of data requested, resource constraints, and lack of perceived benefits to the company from participating in the survey. Several of the strategies proposed and tested, however, may have some potential for improving response. Two of these strategies are encouraging better communication within companies between data users and actual respondents, and enlisting the assistance of a few trade associations by asking them to endorse the survey.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Industry Studies Group

Institution/Principal Investigator:

TARP, Inc./John A. Goodman

Availability:

Available from RDESS/Industry Studies Group.

PROJECT:
Dollar Value of U.S. R&D Expenditures Abroad

Objective:

To discuss why foreign affiliates of U.S. firms conduct research and development overseas, and to examine the factors affecting the recent rate of growth of U.S. research and development performed abroad.

Method:

The report is based on mail responses to an inquiry sent to the NSF's Industrial Panel on Science and Technology, and interviews with R&D officials of several major R&D-performing industries. The participants were asked to estimate the growth in company R&D expenditures abroad during 1983 and 1984, to explain the factors behind projected changes, and to evaluate the effect of recent tax changes on R&D activities conducted abroad.

Major Findings:

Responses from the participants indicated that the growth of research and development overseas is primarily tied to site-specific manufacturing and sales needs. Many U.S. multinational firms are increasingly undertaking R&D activities overseas to benefit from the technological advances being made by researchers in other countries. The leveling-off of the dollar value of U.S. company-funded research and develoment performed overseas during 1981 and 1982, which followed an average annual growth rate of 16% between 1974 and 1980, was not attributed to a deemphasis of research and development. Rather, it was principally caused by the appreciation of the U.S. dollar relative to other currencies, and the recession-induced decreases in revenue from overseas production.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Dollar Value of U.S. R&D Expenditures Overseas Declined in 1982," *Highlights*, NSF 83-329, December 30, 1983, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Estimates of Company-funded Industrial R&D Expenditures for 1984 and 1985

Objective:

To provide estimates of companies' own financing of research and development in major industries for 1984-85 and to outline the factors, such as the Economic Recovery Tax Act (ERTA) of 1981, that affect the funding of these activities.

Method:

The report is based on information obtained from two sources: (1) Mail responses to an inquiry sent to members of the NSF Industrial Panel on Science and Technology, and (2) interviews with R&D officials representing firms in the major R&D-performing industries. Of the 102 company representatives con-

tacted during April-June 1984, replies were received from 86. The respondents were asked to estimate the growth, if any, in company-funded R&D expenditures over the previous year for 1984 and 1985, and to identify the factors they believed to be responsible for any changes. They were also asked to assess the effect on their R&D budget of R&D tax credits from ERTA.

Major Findings:

Total company-funded expenditures for research and development in the United States are estimated to be $49 billion in 1984, an increase of about 12% over 1983. As of mid-1984, most company R&D officials are anticipating the same rate of growth in research and development for 1985. Factors behind these overall R&D expenditure growth rates are increased confidence in the economy as a whole, and a renewed commitment to research and development as a means to ensure future profits and market share. About one-third of the respondents said that their R&D budgets were influenced by the R&D tax credits in ERTA.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Plans for Company-Funded Research and Development Show 12% Annual Increases Through 1985," *Highlights*, NSF 84-329, October 15, 1984, available from SRS/Editorial and Inquiries Unit.

PROJECT:
Impact of Foreign R&D Funding on U.S. Private R&D Spending

Objective:

To examine the impact of foreign expenditures on industrial research and development. It is hypothesized that industrial research and development in Japan and in Europe will elicit a competitive response in the United States.

Method:

Expenditures on industrial research and development in Japan and in Europe are included in regression equations where private R&D expenditure in the United States is the dependent variable. Data on scientists and engineers engaged in research and development in industry are used to confirm the results of the first phase.

Major Findings:

The ability of regression models to predict private industrial R&D expenditures tends to improve when foreign R&D expenditures are included: Japanese industrial research and development appears to elicit a stronger reaction from U.S. firms than does European R&D expenditures. There is evidence that industrial R&D expenditures by different countries are interdependent.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

National Planning Association/Nester Terleckyj

Availability:

Final report expected in March 1985.

PROJECT:
New Public Stock Offerings in Small, High-Technology Companies

Objective:

To prepare tabulations representing new public offerings and subsequent offerings of stock in small, high-technology companies from 1976 to 1983.

Method:

The data are to be taken from a computer data bank on public stock offerings maintained by the contractor. Offerings will be classified in accordance with the Standard Industrial Classification.

Major Findings:

Financings increased sharply from 1976 to 1983.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Securities Data Company, Inc./Robert Bing

Availability:

Report available for examination in the SRS/Science Indicators Unit.

PROJECT:
Research and Development in Industry, 1982

Objective:

To provide data on the resources allocated to research and

development by domestic firms. These statistics are published annually and present historical trend information in addition to current survey-year data.

Method:

The annual survey of industrial research and development is conducted by the Bureau of the Census for NSF. Companies surveyed are selected from a sample of 15,000 companies. All manufacturing and selected nonmanufacturing companies with 500 or more employees are surveyed every year; those with fewer than 500 employees are surveyed at rates depending upon the industry and upon their expenditures for research and development. When companies do not provide the requested data, the Census Bureau estimates their expenditures, based on earlier reports and/or industry averages.

Major Findings:

Industrial R&D expenditures totaled $59 billion in 1982, a constant-dollar increase of 7.3% over the previous year's level. This rate of growth was significantly higher than the 5.5% average annual rate recorded between 1975 and 1981. Despite the recession, companies' own R&D funding rose 6% in real terms during 1982. In addition, led by an increase in funding from the Department of Defense, Federal support of industrial R&D activities rose even faster than private financing in 1982—10% in constant dollars. The increase in total industrial R&D expenditures, combined with level net sales, caused the overall R&D funds/net sales ratio to jump from 3.1% in 1981 to 3.7% in 1982. This was the largest annual change ever recorded in the 25-year history of this data series. The number of full-time-equivalent R&D scientists and engineers increased 5% in 1982 to 536,000.

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability

"Despite Recession, Companies' Own R&D Funding Rose 13% During 1982," *Highlights*, NSF 84-314, May 14, 1984, available from SRS/Editorial and Inquiries Unit. Detailed Statistical Tables, NSF 84-325, available late 1984 from SRS/Editorial and Inquiries Unit.

PROJECT:
R&D Expenditures in the Service Industries

Objective:

To develop better estimates of current service-sector R&D expenditures, and to recommend methodology for continued improvement in the measurement of service-sector R&D activities. In addition, some insight will be gained into the rationale by which service-sector managers determine R&D funding levels.

Method:

The research will be conducted in three stages: (1) Service-industry managers in five service industries, will be interviewed in an attempt to understand their decision process with respect to R&D expenditures; (2) using extant data, 100 manufacturing companies will be analyzed to estimate the proportion of their R&D expenditures spent by their service-sector components; and (3) the results will be integrated and studied to gain insight into the potential impact of the service sector on total research and development, as well as into the possibility of revising the methodology to improve data collection on the R&D activities of service industries.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

Cooper and Company/Gershon Cooper

Availability:

Results may be obtained in 1985 from SRS/Editorial and Inquiries Unit.

PROJECT:
Trends in R&D Limited Partnerships

Objective:

To collect data on the extent and structure of R&D limited partnerships (RDLP's), and to evaluate the probable near-term growth characteristics of this funding mechanism. The value of using data on RDLP's to serve as indicators of technical activity will also be explored. The study will provide valuable data and insight on a new and growing source of R&D funding in the industrial sector, which is the major performer of research and development in the United States.

Method:

The report will be based on interviews with officials both of companies using the RDLP mechanism and of investment houses. The Principal Investigator will also cooperate with other Government agencies concerned with RDLP's and will use their information as appropriate. The data collected will include amount and sources of funds, technical fields supported, source of technical concept, and fractions of funds earmarked for research and development.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Industry Studies Group

Institution/Principal Investigator:

New York University/Herbert I. Fusfeld

Availability:

Early 1985 from SRS/Editorial and Inquiries Unit.

PROJECT:
Trends in Small Companies' R&D Expenditures

Objective:

To provide and analyze data on the resources allocated to research and development by companies with fewer than 500 employees. The data cover the years 1971, 1976, and 1981, and are presented by individual industry.

Method:

The data cited in this study were contained in a special tabulation from the annual survey of industrial research and development, which is conducted by the Bureau of the Census for NSF. R&D data were collected from firms with fewer than 1,000 employees and less than $1 million in R&D expenditures only for those years—1971, 1976, and 1981—in which a new sample was drawn. Data for this group of companies were estimated in other years.

Major Findings:

R&D-performing companies with fewer than 500 employees spent $1.8 billion of their own and Federal funds on research and development in 1981, less than 4% of total industrial R&D expenditures in that year. Small nonmanufacturing firms, including commercial laboratories, service-oriented businesses, and mining companies, were responsible for almost one-fourth of these expenditures. Small R&D-performers received $356 million, 2% of all Federal R&D funds awarded to industry in 1981. This level is expected to rise during the eighties as small companies benefit from the Small Business Innovation Development Act. The ratio of total R&D expenditures to net sales for small R&D-peforming manufacturing firms was 1.5% in 1981, compared with 3.2% for all companies. Firms with fewer than 500 employees employed 32,000 full-time-equivalent R&D scientists and engineers, over 6% of the total number working in all U.S. industrial laboratories in 1981.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Industry Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

Trends in Small Companies' R&D Expenditures, Report, NSF 84-324, June 1984, available from RDESS/Industry Studies Group.

PROJECT:
Venture Capital Investment in Small, High-Technology Companies

Objective:

To estimate total annual funding of small companies by venture capital firms, and to estimate the funding of high-technology companies by field of technology.

Method:

A data base, that covers new financing by venture capital companies, is used to provide statistical summaries.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Venture Economics/Norman D. Fast

Availability:

Venture Capital Investment Trends: 1981-1983, will be available for inspection in SRS/Science Indicators Unit in late 1984.

section III. funding of science and technology

c. universities and colleges

PROJECT:
NSF Baseline Survey of Major Academic Research Instruments in Academic Settings

Objective:

To develop quantitative indicators of the status of, and need for, equipment for scientific research in U.S. universities and colleges through a nationally representative survey of higher education institutions.

Method:

The contractor is conducting a stratified probability sample of 43 universities from a universe of the approximately 160 largest academic R&D performers. During Phase I of the survey, departments within universities were subsampled in the physical and computer sciences and engineering to collect information on equipment costing between $10,000 and $1,000,000. This study is based on the "Instrumentation Indicators Feasibility Study" completed for NSF by Westat, Inc., in early 1982. Phase II of this projected 3-year study will subsample departments within universities in the biological, agricultural, environmental, and medical sciences.

Major Findings:

University researchers classified about one-fourth of the items in their 1982 research equipment inventories as obsolete and no longer in use. Of all academic research equipment listed in the 1982 inventories, only 18% was characterized as "state-of-the-art." More than 90% of departmental chairpersons in each of the three surveyed fields reported that the lack of equipment inhibited the conduct of critical research. Two-thirds of all academic research systems were acquired partly or entirely with Federal funds.

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

Westat, Inc./Lance Hodes

Availability:

"One-fourth of Academic Research Equipment Classified Obsolete," *Highlights*, NSF 84-312, April 18, 1984, available from SRS/Editorial and Inquiries Unit. Other publications resulting from this survey are projected to be available from SRS/Editorial and Inquiries Unit during 1984.

PROJECT:
R&D Funds in Academic Science and Engineering, FY 1982

Objective:

To collect annual data from academic institutions spending over $50,000 for separately budgeted research and development.

Method:

FY 1982 data were tabulated and analyzed on the basis of responses to questionnaires from 81% of the 563 institutions and their affiliated federally financed R&D centers. There were several data elements: Source of support, amount allocated to basic research, total and federally financed R&D expenditures by discipline, research equipment expenditures from separately budgeted R&D funds by discipline, and capital expenditures for scientific and engineering (S/E) activities. The survey was closed out in July 1983.

Major Findings:

Academic separately budgeted R&D expenditures in FY 1982 in constant 1972 (deflated) dollars showed no measurable change over FY 1981 levels. Federally funded R&D support showed a 3% constant-dollar decrease during the same time. Industry funding of academic research and development was up by 6% in constant dollars. Academic basic research expenditures decreased by 1% in constant dollars but continued to account for two-thirds of all academic R&D activities. Expenditures for S/E research equipment accounted for about 6% of total academic R&D spending.

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

"Non-Federal Funding for Academic R&D Activities Increased at Faster Pace than Federal Funding in Fiscal Year 1982," *Highlights*, NSF 84-307, April 27, 1984, and *Academic Science/Engineering: R&D Funds, Fiscal Year 1982*, Detailed Statistical Tables, NSF 84-308, June 1983, National Technical Information Service, Springfield, Virginia 22161, available from SRS/Editorial and Inquiries Unit. Access to the public-use tapes and documentation for their use are described in the *Data User Guide* and Addendum, December 1983, available from the RDESS/Universities and Nonprofit Institutions Studies Group.

PROJECT:
R&D Funds in Academic Science and Engineering, FY 1983

Objective:

To collect data from academic institutions spending over $50,000 for separately budgeted research and development.

Method:

Over 560 institutions and 19 affiliated federally financed R&D centers received the questionnaires for the FY 1983 survey. There were several data elements: Source of support, amount allocated to basic research, total and federally financed R&D expenditures by discipline, research equipment expenditures from separately budgeted R&D funds by discipline, and capital expenditures for scientific and engineering activities. The survey was closed out in June 1984.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section/Universities and Nonprofit Institutions Studies Group

Institution/Principal Investigator:

[Intramural]

Availability:

It is anticipated that Detailed Statistical Tables will be published by summer 1985 and will be available from SRS/Editorial and Inquiries Unit.

section III. funding of science and technology

d. other

PROJECT:

Methodology for the International Comparison of R&D Expenditures

Objective:

To assess and improve techniques for comparing R&D expenditures for different-sized countries.

Method:

There is no widely accepted way of comparing R&D expenditures in different countries. It is difficult to compare measurements in different national currencies: exchange rates reflect monetary phenomena, while currently available purchasing power parities place a low weight on R&D costs in the different economies. Measures of R&D expenditure as a proportion of national economic activity have a common unit of measurement (percentage), and correct for the different size of the economies under study, but require a measurement of the size of the national economy. Two possible measures of national economic size, gross national product and gross domestic product, are evaluated for their theoretical relationship to R&D expenditures, consistency with the methodologies of R&D data collection, availability, and practical impact on the ratios to be analyzed.

Major Findings:

Gross domestic product corresponds best to the definitions used to collect R&D expenditure data, and is available for the major countries studied in *Science Indicators*. The gross national product, however, may be a better measure of the opportunities for R&D expenditure, but comparable R&D data are not available. The choice would have had an impact on the analysis in *Science Indicators—1982*; the difference is insignificant, however, when revised and updated data are used.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

[Intramural]

Availability:

National Economic Activity and the Comparison of R&D Expenditures in Countries of Different Size. Will be available in early 1985 from SRS/Science Indicators Unit.

section IV. outputs and impacts

a. innovations and inventions

PROJECT:
Aggregate Indicators of Technology and Technology Innovation

Objective:

To extend the investigator's previous study on computers to provide a general method for measuring the advance of an industry's technological performance through time.

Method:

Three industries will be selected from such possibilities as general-purpose assembly robots, logic analyzers, and solar energy. Data on firms will be collected and used in further studies of technology transfer, the effect of firm size on innovativeness, and the relation between R&D expenditure and innovation output.

Cost is regressed against performance and date of introduction for all models of the technology. Performance will be measured in terms of the value of the product to users, and possibly will be calculated as a composite of a great number of technical variables.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Texas/Kenneth E. Knight

Availability:

Final report expected in November 1985.

PROJECT:
Conference on Methods for Measuring Technological Progress

Objective:

To bring together experts who will discuss and compare various methods for measuring the advance in individual technologies with time.

Method:

A workshop was held at which papers were presented and discussed. The workshop coordinator is preparing a report that will include the presentations and summaries of the discussion together with an evaluation of the individual methods.

Major Findings:

The methods can be classified into several groups. They probably can be applied to technologies at any level of aggregation. The choice between methods depends on the analyst's needs, the peculiarities of the data, and different ways of conceptualizing technological progress. All methods require the use of judgment and professional familiarity with the technology studied, and all are hampered by the scarcity of data.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Dayton/Joseph P. Martino

Availability:

Proceedings of a Workshop on Technology Measurements Held at Dayton, Ohio, October 12-14, 1983, available from the SRS/Science Indicators Unit.

PROJECT:
Development of a Mechanism for Linking NSF Industrial R&D Data to Other Data Bases

Objective:

To provide statistical data and the linking mechanism that can be used by researchers in analyzing the relationships between R&D funding and other economic variables.

Method:

The Census Bureau will create a mechanism for researchers to better utilize the NSF/Census Bureau industrial R&D data base for the years 1972-81 (collected on an enterprise basis) in conjunction with other economic data sets collected on an establishment basis. To date, one of the major constraints in merging the NSF R&D data base is that these data are collected by enterprise. This project will develop the mechanism to enable researchers to use the R&D data with other data sets (collected via a different reporting unit) and will pilot test the system to ensure validity.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Industry Studies Group

Institution/Principal Investigator:

Bureau of the Census/John R. Norsworthy

Availability:

The initial data file will be completed by fall 1984, and the pilot tests of the system will be completed by spring 1985. Researchers interested in accessing these data files should contact the RDESS/Industry Studies Group.

PROJECT:
Development of New Indicators of Industrial Innovation

Objective:

To test the feasibility of expanding the collection, analysis, and dissemination of information that can serve as new indicators of industrial innovative activity.

Method:

The investigator will collect data via a mail survey on new indicators of technological innovation from a large group of firms in the United States. This project builds upon two years of work at Massachussetts Institute of Technology's Center for Policy Alternatives that demonstrated the feasibility of collecting a broader range of data on industrial innovation than is currently available. The need for these data is based on the fact that many activities other than research and development—such as marketing research—contribute to the innovation process in the private sector. The investigator will compile and analyze the data collected, and debrief a subgroup of respondents.

Major Findings:

NA

Responsible SRS Organization:

R&D Economic Studies Section (RDESS)/Industry Studies Group

Institution/Principal Investigator:

Boston University/John A. Hansen

Availability:

An executive summary of the findings and copies of the final report will be available in Fall 1984 from RDESS/Industry Studies Group.

PROJECT:
The Measurement of Technological Change

Objective:

To extend the author's previous work so as to develop a method of measuring technological progress. To apply the method to farm tractors and aircraft. To compare the results with those obtained by using other methods.

Method:

For each technology, determine surfaces of constant probability density in terms of the performance variables. Determine the distance between surfaces probabilistically by an application of discriminant functions. This distance represents the amount of progress from one surface to another. Dimensional analysis was investigated as a way of reducing the number of variables to be studied.

Major Findings:

Separate indices were developed to represent advances in the deep structure and the surface structure of the two technologies studied. The separate influences of incremental and radical innovations were studied, as well as the influence of the advances in different component technologies. Quantitative estimates were made of the effects of these and other types of innovation on overall progress in both technologies.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

New York University/Devendra Sahal

Availability:

Measures of Technology, available for inspection in SRS/Science Indicators Unit.

PROJECT:
Measuring Technical Change Through Product Attributes

Objective:

To extend the investigator's previously developed method of measuring the progress of a given technology over time. The method combines the important quantitative features of the technology into a single index. To apply the improved method to milling machines, turbine engines, and turbine-powered airliners.

Method:

A production-function method was developed and implemented through regression. Cost of technological output was treated as a function of technological characteristics and time.

Major Findings:

The calculation produced anomalous results when the tech-

nological characteristics chosen were an array of technical product characteristics. Better results were obtained when a single variable representing utility to users was employed.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Rand Corporation/Arthur Alexander

Availability:

Measuring Technological Change of Heterogeneous Products, available for inspection in SRS/Science Indicators Unit.

PROJECT:
Measuring Technological Progress Through Tradeoff Surfaces

Objective:

To develop a measure of level of technological performance for technologies that are characterized by more than one performance characteristic; to extend an existing method for this purpose. To apply the method to four technologies: power transistors, propeller-driven aircraft, jet engines, and clipper ships.

Method:

For each technology, the devices are grouped into sets that are equivalent in performance. Each set is fit with a tradeoff surface in multidimensional space. A distance measure between the surfaces is defined to represent the degree of progress from one to another.

Major Findings:

Families of tradeoff surfaces were calculated for each technology. In some cases, surfaces for different time periods intersected. The need was discovered to make sure that all relevant variables are included and that the variables used really are traded off against one another.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Dayton/Joseph P. Martino

Availability:

An Investigation of the Tradeoff Surface Technique for Technology Measurement, available for inspection in SRS/Science Indicators Unit.

PROJECT:
Patenting in the United States by Various Countries in Various Fields of Technology

Objective:

To provide current and time-series data on patenting in the United States for 55 product fields and 10 designated technology fields, analyzed by country of origin, sector of patent owner, year of patent application, and year of patent grant.

Method:

Data are based on the computer file of patenting data of the Office of Technology Assessment and Forecast. They are converted from the Patent Office Classification system to the Standard Industrial Classification system for 55 product fields, by a revised concordance.

Major Findings:

Data covering the years 1963-83 show the increasing importance of foreign inventions and some decline in patenting by U.S. industry, with increases since 1979.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane.

Availability:

Patenting Trends in the United States and Other Countries: Fractional Count Report, 1963-1983 and *OTAF Custom Report: Selected Technologies, 1969-1983*, available from the SRS/Science Indicators Unit in late 1984.

PROJECT:
Patent Office Concordance Review and Workshop

Objective:

To update and improve the "concordance," the computer program developed by the Patent Office to convert patent counts classified in terms of the Patent Office classification system to the Standard Industrial Classification.

Method:

Complete documentation for the concordance will be developed and studied. A workshop of experts in the use of patenting data made criticisms and suggestions. A final report to NSF will summarize these steps and make recommendations for changes in the concordance. Changes agreed upon will be implemented.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane

Availability:

Final report will be available in late 1984 from the SRS/Science Indicators Unit.

PROJECT:
Relative Share of World Patents in National Patent Markets

Objective:

To study the relative technical advantage of the United States, as represented by patenting data, in comparison with West Germany, Japan, the United Kingdom, and France, in various product fields and in two time periods.

Method:

The international patent file provided by Derwent was used to determine the rates of patenting by these countries in various recipient countries in 1975-77 and 1980-82 in each of six R&D-intensive product fields, and in two mature product fields. Revealed Advantage Indices were calculated and plotted to show the areas of U.S strength and weakness and changes in those areas.

Major Findings:

During the two periods studied, U.S. inventors placed a greater emphasis on patenting in the laser, microbiology-enzymology, drug, and integrated circuit technologies than did inventors in the rest of the world. Japanese inventors were particularly active in the second period in integrated circuits, in lasers, and in telecommunications, while inventors from West Germany placed relatively great emphasis on inventions related to internal combustion engines.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane

Availability:

Relative Shares of World Patents in National Patent Markets, available from the National Technical Information Service, Springfield, Virginia 22161, PB 84-229780, $11.50 (paper copy), $4.50 (microfiche).

PROJECT:
University Patenting in the United States

Objective:

To provide time-series data on patenting in the top 100 R&D universities in the United States, by institution, year of patent application, and year of patent grant.

Method:

Data are drawn from the patent data file of the Office of Technology Assessment and Forecast for the years 1969-83. Analyses include an assessment of patent output by R&D rank of the institution (based on total R&D expenditures in 1982), control of the institution (public versus private), and type of institutional patent policy (e.g., use versus nonuse of patent management organization).

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Office of Technology Assessment and Forecast, U.S. Patent and Trademark Office/John F. Terapane

Availability:

Tabulations will be available for inspection in the SRS/Science Indicators Unit in late 1984.

PROJECT:
Updating Indicators of Technological Innovation Using Patent Examiners' Citations

Objective:

To measure inventive activity using patent statistics, differentiating between patents that are significant technically and commercially, and those that are less so.

Method:

Each patent is weighted by the number of times it is cited by examiners of subsequent patents. All patents issued during the

1971-80 period are tracked to determine the number of examiner citations received from patents issued in the 1971-82 period. The patents are disaggregated by the country of residence of the inventor and of the assignee, and are grouped into 55 classes corresponding to an arrangement of the U.S. Standard Industrial Classification.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Mark P. Carpenter

Availability:

A report will be available from the SRS/Science Indicators Unit late in 1984.

section IV. outputs and impacts

b. bibliometrics

PROJECT:
Co-Citation Cluster Development as Science Indicators

Objective:

To develop a new indicator of scientific progress based on co-citation cluster analysis methodologies.

Method:

Co-citation clusters drawn from the *Science Citation Index* data base were screened to determine year-to-year continuities. Quantitative characteristics of these clusters were studied to monitor important developments in research specialties, as reflected in the research literature.

Major Findings:

This project has resulted in the automation of inter-year cluster links and the formation of all strings of clusters found in 10 yearly sets of *Science Citation Index* co-citation clusters, 1970-79. The data base thus created can be regarded as a resource for the study of specialty development in the sciences and engineering.

Over the 1970's, almost three-fourths of the co-citation clusters show continuity for at least the following year. Statistical variables that were examined include the following: impact, recency, intellectual focus, literature size and dispersion, individual productivity, geographic focus, level of research (basic, applied), and cross-disciplinary orientation.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Institute for Scientific Information/H. Roberts Coward

Availability:

Final report is available for inspection in the SRS/Science Indicators Unit.

PROJECT:
Cross-National Bibliometric Comparisons

Objective:

To examine differences in the bibliometric characteristics of research papers from different countries, field by field, in order to see if these differences significantly affect the interpretation of current publication and citation indicators.

Method:

Bibliometric analyses were conducted on publications from 15 countries using the *Science Citation Index* source tapes. All of the citation data used in the cross-country analyses were developed from the exact-matched citation tapes. The project provided several new indicators of the output of research including the rapidity of a nation's use of research results in subsequent research, international differences in the use of basic research findings in applied research, and changes in the quantity of research described in the average report. This project also tested some of the operating assumptions that underlie the literature indicators used in the *Science Indicators* reports.

Major Findings:

The basic-to-applied character of these research articles was found to be very similar from country to country within fields, and quite stable over the 1973-79 period. In particular, the United States showed no significant differences from other countries taken as a group. The high citation rates to U.S. research articles cannot be ascribed to differences in research level.

An examination of the length of all articles in this set of science and technology journals showed that those on the subject of chemistry were the shortest, and those on mathematics and earth/space sciences were the longest. U.S. versus non-U.S. comparisons showed that the United States had shorter papers in biology, whereas it had longer papers in mathematics than did non-U.S. countries.

The results of citing time varied considerably by field, subfield, and country. Influential factors included number of citing articles, number of articles to be cited, and the individual citing profiles over time.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Francis Narin

Availability:

Three reports are available from SRS/Science Indicators Unit: *Variations in Research Level Across Country and Field*, April 1982; *Variations in Number of Pages Per Paper Across Country, Field, and Year*, July 1982; and *Variations in Reference and Citation Time, Distribution and Spread Across Country and Field*, June 1983.

PROJECT:
Indicators of the Rate of Advance of Science

Objective:

To create and validate quantitative indicators of the rate of advance of two different fields of science—one rapidly advancing (cyclic AMP) and one relatively slow-moving (photo-

synthesis). Potential key events in the development of the fields will be identified.

Method:

The most highly cited papers in the fields are identified and then clustered by co-citation methods. The clusters, representing key events, are mapped in two dimensions, by centroid scaling, to distribute them over time and to show their proximity to each other. Published reviews and interviews with experts in the fields will serve to check the key events.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Elliott Noma

Availability:

Final report expected in late 1985.

PROJECT:
Measuring the Growth of Knowledge in the Biomedical Sciences

Objective:

To develop and test bibliometric techniques for measuring the growth and decline of scientific specialties in the biomedical field.

Method:

Research grants made by the National Institutes of Health will be divided into subject area specialties within biomedicine. This will be done by cluster analysis of key words appearing in the grant titles and teams assigned by professional indexers. Changes in cluster size will represent changes in the amount of work being done in the corresponding specialty. Interviews with senior scientists will be used to check the results of the cluster analysis.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Stanford University/Everett M. Rogers

Availability:

Final report expected June 1985.

PROJECT:
Updating and Maintaining Bibliometric Data Series

Objective:

To update the statistical data set of scientific and technical literature indicators used in the *Science Indicators* reports of the National Science Board.

Method:

Data from the 1973-82 *Science Citation Index* issued by the Institute for Scientific Information will be compiled into measures and indices of scientific and technical publications and citations. Data will be disaggregated by field and subfield, by countries of authors and of journals, by levels of research (basic and applied), and by U.S. R&D-performing sectors. They will also show the most active institutions in each sector, and cooperatively authored articles.

Major Findings:

The major results of this ongoing data project appear in the National Science Board's *Science Indicators* reports.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Computer Horizons, Inc./Mark P. Carpenter

Availability:

Data are available for inspection in the SRS/Science Indicators Unit.

section IV. outputs and impacts

c. economic implications

PROJECT:

Organizational and Strategic Factors Affecting the Distribution of Returns from Innovation and International Technology Transfer

Objective:

To identify, measure, and analyze the factors that affect the ability of firms to profitably exploit innovations abroad.

Method:

The project will proceed in two steps. First, three industries in the United States and in the United Kingdom will be studied qualitatively to identify important influences on the ability of firms to capture the profits that are earned when these innovations are transferred internationally. Second, data on the factors that were found to be important in the first phase will be collected and will be used in a regression model to predict the distribution of the returns from innovation in a fourth industry.

Major Findings:

NA

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of California, Berkeley/David J. Teece

Availability:

A report should be available from the SRS/Science Indicators Unit during the Summer of 1986.

PROJECT:

The Relationship of Agricultural Research and Development to Selected Socioeconomic Change in the Farm Sector

Objective:

To examine the impact of agricultural research and development on selected characteristics of the U.S. farm sector and to assess the validity and reliability of various agricultural R&D indicators such as expenditures and scientific personnel data.

Method:

The research focused on possible relationships between research and development and changes in farm commercialization and concentration and in the farm labor force for the Nation as a whole. The project examined different types of R&D output, levels of effort to diffuse such outputs, and the resultant effects. A simultaneous equation model was developed to test the various relationships. A comprehensive longitudinal data set was also created for research and development in the agricultural sector for the period 1915-73.

Major Findings:

Results indicate that publicly financed agricultural research and development has tended to increase average farm size, the number of large farms (i.e., farms of 1,000+ acres), and large farms as a percent of all farms. The greatest impact was in the percent of large farms. With regard to commercialization and employment, it was found that research and development was of little direct significance. The concentration of farming in large farms, however, appears in turn to affect both commercialization and the size of the farm labor force. In addition to funding, the investigators explored the relationship between the number of publications derived from publicly financed agricultural research and the concentration of farms. The number of total publications was found to be an effective predictor of increased farm concentration. Publications in scientific journals, however, failed to perform adequately as an indicator. Further evaluation of this finding would seem to be necessary.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

University of Kentucky Research Foundation/Lawrence H. Busch

Availability:

Final report is available for inspection in the SRS/Science Indicators Unit.

section IV. outputs and impacts

d. other

PROJECT:

Attitudes of the Attentive Public and of Nongovernmental Policy Leaders Towards Science and Technology

Objective:

To produce survey data on the attitudes toward science and technology of several groups, including opinion leaders in science and technology (S/T) policy outside the Government and the portion of the public that is most interested in and informed about S/T issues.

Method:

Two questionnaires were designed, partly overlapping the one used in the 1979 national survey for *Science Indicators*, with the nationwide survey conducted by telephone. Responses were compared with those from the 1979 study.

Major Findings:

Opinions were obtained from samples of the broad public, an "attentive public" knowledgeable about and interested in S/T issues, a potentially attentive group, and opinion leaders in S/T policy outside the Government. The attentives' assessment of the benefits from S/T was found to be even more favorable than that of the general public, with potential attentives falling in between. Policy leaders are still more favorably disposed and have a greater preference for basic, as opposed to applied, research.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Northern Illinois University/Jon D. Miller

Availability

A National Survey of the Non-Governmental Leadership of American Science and Technology and *A National Survey of Public Attitudes Toward Science and Technology*, available for inspection in the SRS/Science Indicators Unit.

section V. international science and technology

PROJECT:
Analysis of Japanese S/T Resources

Objective:

To examine quantitative information on the financial and human resources being invested in Japanese scientific and technological (S/T) activities, and to provide S/T data on Japan that are more detailed and more comparable with U.S. definitions than have been available previously.

Method:

Heretofore underutilized data on Japanese S/T resources will be compiled, evaluated, and analyzed. Various Japanese survey instruments used to collect the data will be examined and compared. New Japanese time series that will be constructed and compared with U.S. data include those on the total number of scientists and engineers cross-classified by subfield and industry group; total Japanese scientists and engineers by occupation, and sector; Japanese expenditures on basic research, and Japanese academic institutions' R&D expenditures. Research will be conducted in both the United States and Japan.

Major Findings:

NA

Responsible SRS Organization:

Office of the Director/International S/T Studies

Institution/Principal Investigator:

University of Michigan/Gary Saxonhouse

Availability:

Final report is expected in Spring 1986.

PROJECT:
A Comparative Study of S/T Personnel in Selected Highly Industrialized Countries

Objective:

To assemble data by which scientific and technical (S/T) personnel in the United States can be compared with those of the United Kingdom, France, and West Germany and to examine significant trends revealed by these comparative data for high technology and critical industries.

Method:

The Principal Investigators visited the selected countries and contacted representatives of industry, educational institutions, and governments in order to identify existing and future sources of data on S/T personnel. Available S/T personnel data were collected from governmental and non-governmental sources, supplemented by information obtained from a wide body of literature on the subject and from officials and recognized authorities in the selected countries and in appropriate international organizations. A special effort was made to evaluate the data bases and to supply background on the comparability of trends among the various countries. Trends in the education, training, and utilization of S/T personnel were analyzed for each of the three European countries. Comparisons were made between these countries and the United States to determine differences in the supply and utilization of S/T personnel.

Major Findings:

Comparative data on the number of natural scientists and engineers showed that in the early 1980's, the United States had 2.6 million natural scientists and engineers in the labor force compared with 621 thousand for West Germany, 633 thousand for France, and 592 thousand for the United Kingdom. Although the United States has more natural scientists and engineers in the labor force than these three countries combined, the U.S. proportion of natural scientists and engineers in the labor force in the early 1980's was about the same as that of other countries.

Experts interviewed in the course of the study agree that scientists and engineers in the United States demonstrate a higher degree of mobility (geographic and occupational) than do their counterparts in the European countries. Engineers in France and West Germany more frequently move into top management positions than do those in the United States and the United Kingdom. Less attention is given in the United States to the systematic training of technicians and establishment of standards than in the European countries. Updating of skills of scientists and engineers is also more systematic in the European countries than in the United States with special tax-supported programs, notably in France. In the United States, larger firms often carry out such training for their staff and, more often than in Europe, it is up to the individual.

Responsible SRS Organization:

Office of the Director/International S/T Studies

Institution/Principal Investigator:

Horizon Institute for Advanced Design/Joseph Mintzes and William Tash

Availability:

Comparison of Scientific and Technical Personnel in the United States, France, West Germany and the United Kingdom, available from SRS/Editorial and Inquiries Unit in early 1985.

PROJECT:
R&D Expenditures in Selected Industrialized Countries

Objective:

To expand the R&D expenditure data base for selected indus-

trialized countries, namely Japan, West Germany, France, and the United Kingdom.

Method:

Onsite data teams will identify foreign data sources. Data will be collected through direct contacts with officials from various sectors including government, industry, higher education, and nonprofit institutions. Reports, surveys, and other literature published in the national language will be examined. An examination of the comparability of the foreign data will be done in terms of U.S. definitions and concepts. Analytical analyses will be conducted on the foreign R&D data and comparisons will be made with U.S. R&D data trends.

Major Findings:

NA

Responsible SRS Organization:

Office of the Director/International S/T Studies

Institution/Principal Investigators:

SRI International/Catherine P. Ailes, Francis W. Rushing, and individual country data teams

Availability:

Data on Japan and West Germany are expected in Spring 1985 and on France and the United Kingdom in late 1985.

PROJECT:
Soviet R&D Statistics

Objective:

To provide updated statistics on R&D investments with particular attention paid to R&D science and engineering (S/E) personnel in the Soviet Union.

Method:

Official Soviet data are analyzed at a disaggregated level and made compatible with U.S. data. Soviet S/E personnel data are adjusted to conform to the NSF concept of scientists and engineers employed in research and development. High and low estimates of the numbers of Soviet R&D scientists and engineers are provided.

Major Findings:

Soviet R&D investments rose through the late seventies and were considerably larger than U.S. investments—both in absolute numbers and in terms of the size of the economy. In 1984, the Soviet Union expended about 27 billion rubles on research and development. This represented 3.65% of their gross national product. Attempts were made to present Soviet S/E personnel data in accordance with U.S. definitions. There were between 1.4 and 1.6 million Soviet scientists and engineers engaged in research and development in 1984. The concentration of R&D scientists and engineers in the labor force was the highest of any country: 9-10 R&D scientists and engineers for every 1,000 persons in the labor force in 1984.

Responsible SRS Organization:

Science Indicators Unit

Institution/Principal Investigator:

Indiana University/Robert W. Campbell

Availability:

Robert W. Campbell, *Soviet R&D Statistics, 1970-1983*, National Science Foundation, 1983, available from SRS/Editorial and Inquiries Unit. Previous reports by Robert Campbell also have useful information and data. See *Soviet R&D Statistics, 1975-1982*, NSF 82SP0636, National Technical Information Service, Springfield, Virginia 22161, PB 84-223015, $10.00 (paper copy) and $4.50 (microfiche); *Soviet R&D Statistics, 1977-1980*, NSF 80SP0727, National Technical Information Service, Springfield, Virginia 22161, PB 82-207408, $7.50 (paper copy), $4.00 (microfiche), and *Reference Source on Soviet R&D Statistics, 1950-78*, also available from SRS/Editorial and Inquiries Unit.

PROJECT:
U.S. and Japanese Engineers: A Comparative Study of Indicators of Their Number, Quality, and Utilization

Objective:

To develop and analyze indicators of the number, quality, and utilization of U.S. and Japanese engineers.

Method:

Information on U.S. and Japanese engineers will be compiled and cataloged from existing data sources. These data will be critically evaluated and analyzed. New data on the career paths of comparable cohorts of U.S. and Japanese engineers will be gathered and analyzed for the purpose of adding substantive insights into these indicators. An evaluation of a sample of engineering curricula in the two countries will provide additional information on the training and knowledge base of engineers. Research will be conducted in both the United States and Japan.

Major Findings:

NA

Responsible SRS Organization:

Office of the Director/International S/T Studies

Institution/Principal Investigators:

Carnegie Mellon University/Henry R. Piehler and Leonard H. Lynn

Availability:

Final report is expected in Summer of 1986.

PROJECT:
West German S/T Resources Profile

Objective:

To provide quantitative information on science and technology (S/T) resources in West Germany.

Method:

S/T data from various sources were examined, compiled, and presented. West German national reports were utilized, as well as data from the Organisation of Economic Co-operation and Development. Comparisons were made with the United States.

Major Findings:

In 1983, West Germany spent $10.5 billion in constant (1975) U.S. dollars on research and development. Although this amount is much smaller in absolute terms than expended by the United States, the two countries' R&D investments are similarly proportionate to their economies. The ratio of R&D expenditures to the gross national product was about 2.6% for both countries in 1983. In 1980, there were 621,000 natural scientists and engineers in West Germany, representing 2.3% of the labor force, a ratio that is about the same as that of the United States (2.4%). In 1983, West Germany spent $7.3 billion in constant dollars on industrial research and development compared with $37.3 billion in constant dollars in the United States. West German R&D expenditures are more concentrated in the chemicals and allied products and electrical and electronics industries than are those of the United States.

Responsible SRS Organization:

Office of the Director/International S/T Studies

Institution/Principal Investigator:

[Intramural]

Availability:

West German S&T Resources Profile and Comparison with the United States, report will be available from SRS/Editorial and Inquiries Unit in early 1985.

appendixes:

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b. intramural publications, 1974-84
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appendix a

principal investigators

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